## Road infrastructure and corridor development

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# Road Infrastructure and

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## 1. INTRODUCTION

The impacts of network infrastructure are usually studied for spatial units such as cities or regions. **Cities** can be conceived as nodes in a network, the development of which is influenced by the quality of links (roads, railways, canals) and of transport nodes (airports, seaports). Thus, one can study the effect of changes in transport links (e.g., high speed rail) on the relative position of cities (cf. Bruinsma and Rietveld, 1993).

Impacts of transport infrastructure change on **regions** can be analyzed when a transport network is connected to a spatial system in terms of zones or regions. By connecting the centroid of each region to a point in the network, changes in the network can be translated into changes in accessibility of regions. Usually, regions are defined in administrative terms.

An opportunity which has received less attention in research is to focus on **corridors**. Corridors can be defined as areas near to links in networks. The difference between corridors and regions is that regions are defined a priori (usually in an administrative way), and corridors can be defined in terms of the shape of a network. During the last 10-15 years the availability of data with a very high spatial detail (individual, postal code) has increased substantially. As a consequence, opportunities to analyze spatial processes by means of spatial units which can be modified according to the features of the topic studied have increased substantially. This has also led to an improvement of possibilities to study the effects of network development on corridors. This is a welcome development since by using more appropriate spatial units of analysis, research can be carried out in a more satisfactory way. A focus on corridors is also important in the eyes of policy makers. Corridors seem to be relevant elements of mental maps of countries and have an intuitive appeal. In physical planning and regional economic policies, corridors regularly appear as relevant units (cf. RPD, 1991).

A closer look at the concept of a corridor reveals that corridors usually relate to road infrastructure. The reason is that road infrastructure has a relatively high number of entry and exit points, so that it really can be expected that land use is affected in the whole area surrounding a road or a highway. The lower the number of entry or exit points, the less relevant the notion of a corridor becomes. For most railway lines for example, distances between subsequent stops are so far, that the corridor concept does no longer apply. An exception may occur in the case of rail systems within metropolitan areas where stops are near to each other.

This paper reports to the results of a broader study on the impact of highway development on corridors in the Netherlands. Two spatial approaches have been used with respect to corridors. One is to use given statistical regions

(Corop-regions [1]). These regions are broader than the corridors, so that they give rise to the disadvantages mentioned above. The advantage is that they allow a rather long time series from 1970 onwards. The other approach is to use postal code areas and combine these so that they form corridors. The advantage is that this leads to an analysis of an appropriately defined spatial unit. A disadvantage is that data are available for a much shorter period.

In the present paper we mainly present results on the basis of Corop-regions. Results of the more refined spatial data are reported in another paper (Jorritsma, Meurs and Rietveld, 1994). A more detailed account of the results of the subject of this paper can be found in Bruinsma et al. (1994).

## 2 THEORY ON ECONOMIC IMPACTS OF TRANSPORT INFRASTRUCTURE

### 2.1 General introduction

As indicated in Table 2.1, transport infrastructure investments have both temporary and permanent effects on the economy. A major temporary effect concerns the stimulation of employment and income during the construction phase via the demand side.

This effect can be studied by means of input-output analysis and there is little controversy about it, except for the fact that one should pay attention to the question how the infrastructure is financed. A tax increase or an increase in interest rates due to government borrowing on the capital market would have a negative impact on consumption or investments, which would counter the initial demand stimulating effect of government spending. Such crowding-out effects are often ignored in regional or urban studies where the infrastructure project is considered to be 'small' compared with the size of the national economy. However, if local projects are financed by means of local financial resources (local taxes), one should of course take into account the impacts of these taxes on investment behaviour of firms in the area concerned.

Another demand related effect of infrastructure occurs in the field of operations and maintenance; this effect is non-temporary. Although maintenance is not an activity which strikes the imagination of the general public as much as new infrastructure projects may do, it is nevertheless an important activity (see: OECD, 1986), with high rates of return on investments.

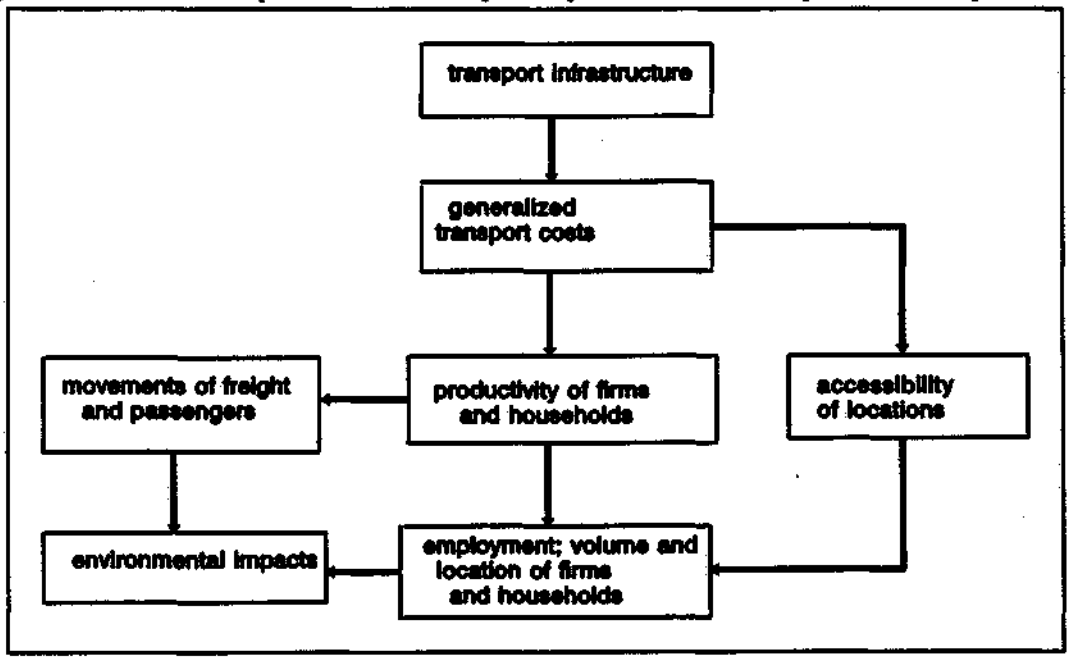
[1] Corop-regions are statistical areas. There are 40 of them in the Netherlands. The average population of a Corop-region is about 400.000 inhabitants (see Appendix 1).

*Table 2.1 Temporary and permanent effects of transport infrastructure investments*

| | Demand side | Supply side |
|---|---|---|
| **temporary effect** | construction effects<br>crowding out | - |
| **permanent effect** | operations and maintenance | effect on productivity<br>and locations of activities |

In this paper, we will focus on the programme effects, i.e. the permanent effects at the supply side. The following scheme shows a number of possible effects which are relevant for an economic analysis of transport infrastructure investments: generalized transport costs, GDP, employment, environment, welfare and equity.

*Figure 2.1 Relationships between transport infrastructure and spatial development*




Transport infrastructure investments lead to changes in **generalized transport costs** via shorter distances or higher speeds which give rise to reductions in fuel, capital and labour costs. Such changes will have impacts in the transport system in the form of mode choice, choice of time of day (in the case of congested networks) and the generation and attraction of trips per zone.

The reduction in generalized transport costs in combination with the changes in transport flows of firms lead to an increase in **productivity** in the firms concerned. This increase in productivity will manifest itself in the form of a change in value added which will on its turn lead to a growth of gross domestic

product (GDP) in the region or country concerned.

Effects on **employment** of infrastructure investment take place among others via substitution and complementarity relationships between labour, private capital and infrastructure. They also occur via differences in growth rates of economies in regions due to the differences in advantages they receive from changes in infrastructure networks.

After the general introduction on infrastructure two impacts on the concerns given above, we now address the issue of employment impacts more in particular. It will be shown that infrastructure investments are not always a panacea for employment growth in certain regions or countries. We will discuss subsequently:
- transport infrastructure as a production factor;
- transport infrastructure and interregional/international trade.

## 2.2 Transport infrastructure as a production factor

Transport infrastructure can be considered as a stock of a certain type of capital available to a region or a country. A general formulation of a production function for sector *i* in region *r*, with various types of infrastructure is:

$$Q_{ir} = f_{ir}(L_{ir}, K_{ir}, IA_r \ldots IM_r) \qquad (2.1)$$

where:

| | |
|---|---|
| $Q_{ir}$ | value added in sector *i*, region *r* |
| $L_{ir}$ | employment in sector *i*, region *r* |
| $K_{ir}$ | private capital in sector *i*, region *r* |
| $IA_r..IM_r$ | infrastructure of various types in region *r* |

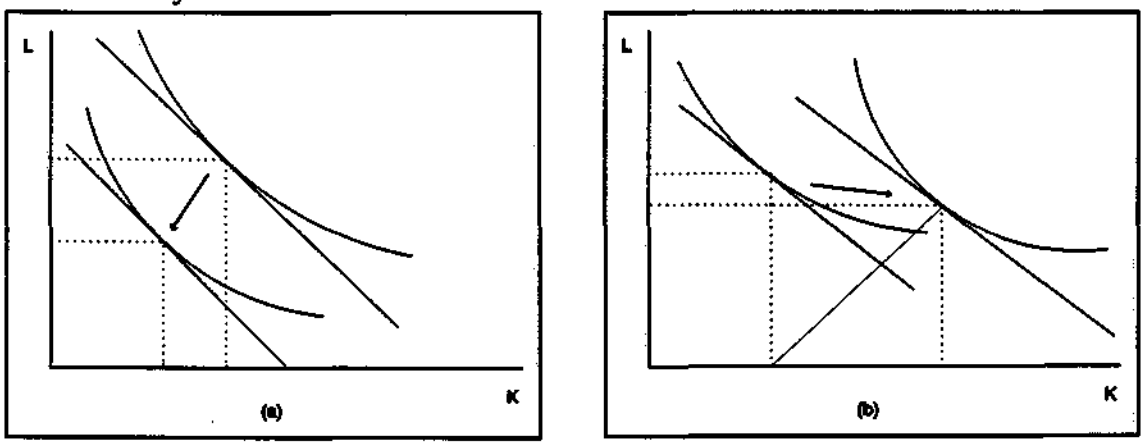
Among the types of infrastructure distinguished are: transportation, communication, energy supply, water supply, education, health services, etc. As far as transport infrastructure is concerned, it is not easy to take into account its *network* properties in the production function approach. One thing one can do is to distinguish various types of transport infrastructure according to their spatial range: intraregional, interregional and possibly international.

A related problem with infrastructure is that its impact may transcend the boundaries of regions. A certain region may benefit from a university or airport, even though these facilities are not located in the region itself. This problem of spatial spill-overs may be solved by using the concept of *accessibility* of certain types of infrastructure in the production function (see e.g. Johansson, 1992). An alternative approach to study the role of infrastructure in production processes is to use cost functions (Seitz, 1993).

What are the services offered by transport infrastructure which increase productivity? First, the improvement of transport infrastructure enables a reduction of the costs for the collection of inputs and the distribution of outputs. Second, improvement of transport infrastructure leads to better functioning of labour markets, which in turn may lead to higher labour productivities. Also, productivity of private capital may increase.

Production functions of type (2.1) can be used to derive demand functions for labour and private capital. With respect to labour demand, two effects can be distinguished. First, an increase in the availability of infrastructure leads to a shift in the optimum allocation of labour $L$ and private capital $K$ at a given level of production. This shift may be such that the total level of both L and K needed to produce the same volume of output is decreased (see Figure 2.2 (a)). But it may also occur that demand for L increases and demand for K decreases (see Figure 2.2 (b)) or vice versa. In all cases, the total costs of private production factors will decrease.

*Figure 2.2 Allocation of labour and capital before and after improvement of infrastructure*



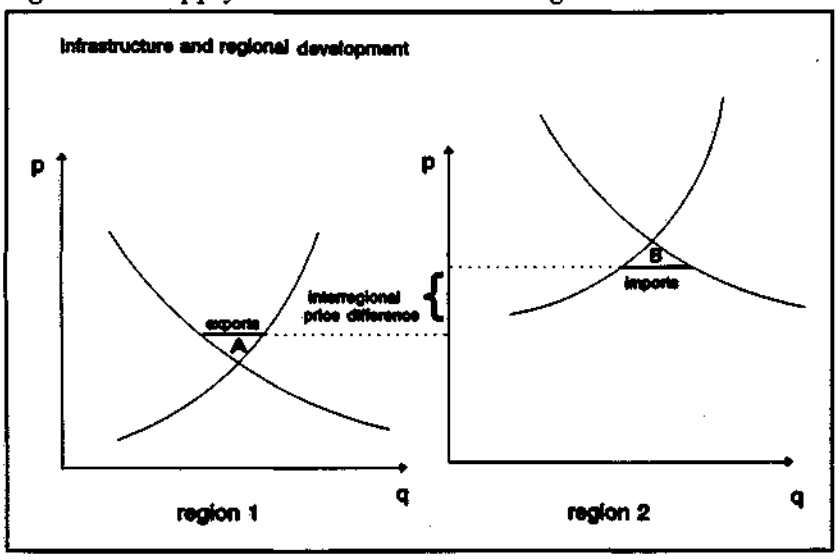

In other words, the direction of the first effect of infrastructure improvement on labour demand is not certain. A second effect is that due to the decrease in the costs of production, output can be expanded. This will under the usual assumptions lead to an increase in the demand for private production factors.

Thus, we arrive at the conclusion that when output remains constant, improvement of infrastructure may lead to a decrease in labour demand. On the other hand, a decrease in production costs can induce a higher output, which has a positive effect on employment. These results hold true when we ignore the impacts of transport infrastructure on interregional or international trade. A discussion of the latter is given in the next section.

## 2.3 Transport infrastructure and interregional/international trade.

The standard model of interregional trade is illustrated in Figure 2.3. Export takes place from region 1 to region 2 when transportation cost is less than the difference in equilibrium price for a certain good in both regions. Compared with the situation without trade an additional surplus is created consisting of areas A (accruing to producers in region 1) and B (accruing to producers in region 2). Thus, both regions benefit from trade according to the model.

*Figure 2.3 Supply and demand in two regions*




Improvement of infrastructure leads to a decrease in transportation costs and hence to an increase in transportation volumes. The equilibrium price in region 1 will increase and the price in region 2 will decrease. Thus, in region 2, consumers benefit from the improvement in infrastructure, whereas producers are negatively affected. In region 1 it is the other way around. In employment terms, region 1 benefits, but region 2 is hurt by the improvement of transportation infrastructure.

An important aspect of the above is that improved transport infrastructure enables firms to make use of economies of scale in production. This leads to specialization tendencies of regional economies with positive impacts on certain sectors and negative impacts on others.

In terms of the types of infrastructure considered, it can be noted that in the productivity approach the intraregional aspects of the services of infrastructure are emphasized, whereas in the trade approach the interregional aspects come to the fore.

# 3 THE DEVELOPMENT OF ACCESSIBILITY IN DIFFERENT ZONES IN THE NETHERLANDS

## 3.1 The development of regional employment in the Netherlands

Many European countries have witnessed an 'urban-rural manufacturing shift' during the past decades (cf. Keeble et al., 1983). To analyze the urban-rural manufacturing shift in the Netherlands it is useful to divide the country into three zones: the Randstad, the intermediary zone and the peripheral zone (see Appendix 1). The Randstad is a highly urbanized area, which was characterized by the highest economic and employment growth before 1970. The four largest Dutch cities are located in this region (Amsterdam, Rotterdam, The Hague and Utrecht). After 1970 a shift took place from the Randstad to the intermediary

zone. This shift did not only relate to a migration of population out of the Randstad, but also to a low rate of employment growth in this area; employment growth in the Randstad was below the national average. The intermediary zone benefitted from this trend; this area showed growth rates of employment, which are above the national average (see Table 3.1).

*Table 3.1 Development of employment in the Netherlands*

| | 1970 | 1975 | 1980 | 1985 | 1990 |
|---|---|---|---|---|---|
| Netherlands | 100 | 101 | 105 | 100 | 115 |
| Randstad | 100 | 98 | 102 | 97 | 109 |
| Intermediary zone | 100 | 104 | 109 | 104 | 123 |
| Peripheral zone | 100 | 99 | 105 | 100 | 112 |

Source: Own calculations from: CBS, REJ.

The peripheral zone was characterized by a relatively strong emphasis on agriculture in the past. The economic development in this zone stayed behind the other zones before the 1970s. In the period 1970-1990 the employment growth was only slightly lower than that of the national average; in most periods its growth was even higher than that of the Randstad.

If one wants to know to what extent these developments are caused by differences in the sectoral structure between the regions one can carry out a shift-share analysis to compensate for such differences. The results of such an analysis based on 12 sectors are shown in Table 3.2.

*Table 3.2 Relative shifts in the different zones in the Netherlands*

| | '70-'75 | '75-'80 | '80-'85 | '85-'90 |
|---|---|---|---|---|
| Randstad | -0.04 | -0.02 | -0.02 | -0.04 |
| Intermediary zone | 0.06 | 0.01 | 0.02 | 0.04 |
| Peripheral zone | 0.00 | 0.01 | 0.00 | -0.02 |

Source: Own calculations from: CBS, REJ.

The shifts in the Randstad are negative in all five-year periods. This means that the negative development of the Randstad is not caused by its sectoral composition, but by other factors. The shifts are clearly positive in the intermediary zone; here the locational profile appears to be clearly favourable compared with the average.

### 3.2 The development of the accessibility in the different zones

Highway infrastructure in the Netherlands was mainly constructed in the period 1960-1975. After 1975 the investments in road infrastructure decreased, which was partly caused by the growing deficits of the government, but also because of the growing attention to the negative external effects of road transport (see Table 3.3).

*Table 3.3 The development of roads with a dual carriage way[2] outside residential areas (1966 = 100)*

| | 1966*) | 1970 | 1975 | 1980 | 1985 | 1990 |
|---|---|---|---|---|---|---|
| Netherlands | 100 | 168 | 250 | 296 | 315 | 372 |
| Randstad | 100 | 150 | 189 | 196 | 196 | 241 |
| Intermediary zone | 100 | 161 | 252 | 301 | 313 | 346 |
| Peripheral zone | 100 | 233 | 474 | 654 | 791 | 960 |

*) Before 1966 are no data available.
Source: Own calculations based on: CBS, Statistiek van de wegen.

It is interesting to analyze in which zones infrastructure construction took place most intensively. It appears that the growth rate of kilometres highway was the highest in the peripheral zone, while the network in the Randstad was not extended that much. A reason for this may be that the construction of highways started earlier in the populated Randstad. The construction in the intermediary zone was about the national average. By comparing Table 3.3 with the preceeding tables, it may be concluded that the strong emphasis on construction activity in the peripheral zone, has not led to a clear improvement of the economic position of this area.

### 3.4 Using an accessibility index

The above data relate to infrastructure as an input. The importance of infrastructure is that it provides services to users, however. One way to analyze this is by using an accessibility index. Such an index can be defined as (see e.g., Bruinsma and Rietveld, 1993):

$$B_i = a\Sigma_j M_j / c_{ij}$$

where:
$B_i$ = accessibility index for region i
a = constant
$M_j$ = mass of zone j (mass = employment)
$c_{ij}$ = travel time from zone i to j

[2]The highway system consists exclusively of dual carriage ways.

The travel time is calculated by means of detailed data on speeds on many links (the Basnet system). Travel times between Corop-regions have been computed by means of a shortest route algorithm. From the definition of the accessibility measure, it is clear that there are two major reasons for changes in accessibility: changes in mass M and changes in the network itself. In the present context, we are only interested in the changes in the network. Therefore, we computed changes in accessibility while holding the masses constant.

*Table 3.4 Growth of the accessibility index in different zones (1970 = 100)*

| | **1970** | **1975** | **1980** | **1985** | **1990** |
|---|---|---|---|---|---|
| Netherlands | 100 | 113 | 120 | 125 | 130 |
| Randstad | 100 | 112 | 115 | 118 | 122 |
| Intermediary zone | 100 | 115 | 122 | 126 | 132 |
| Peripheral zone | 100 | 115 | 125 | 133 | 140 |

From Table 3.4 it appears that the accessibility in the peripheral zone grew most strongly, while that of the Randstad grew less. The differences are smaller than of road densities as shown in Table 3.3, because the construction of roads in a zone does not only lead to an increase of its internal accessibility, but also of its external accessibility, so that other regions will also benefit. In addition, it should be noted that the accessibility figures given here are partly based on the underlying road network, which has been less dynamic than the highway system. Therefore, the increase in accessibility is less than the increase in the length of the highways. Again we observe that, although the accessibility in the peripheral zone grew most rapidly, its relative economic position did not improve.

### 3.5 Correlations in the accessibility growth

We consider the question whether the growth in accessibility in the different regions is correlated during various periods. The correlation coefficients between the growth in the above mentioned accessibility index in the different periods are given in Table 3.5.

*Table 3.5 Correlations in the growth of the accessibility index*

| | **'70-'75** | **'75-'80** | **'80-'85** | **'85-'90** |
|---|---|---|---|---|
| **'70-'75** | 1.00 | -0.08 | -0.24 | 0.22 |
| **'75-'80** | -0.08 | 1.00 | 0.58* | 0.21 |
| **'80-'85** | -0.24 | 0.58* | 1.00 | 0.13 |
| **'85-'90** | 0.22 | 0.21 | 0.13 | 1.00 |

* significant correlation

A positive correlation coefficient for subsequent periods means that accessibility increases do not take place in a random way, but that there is a pattern that some regions experience above average accessibility growth and others have below average accessibility growth during successive periods.

It appears that between the periods 1975-1980 and 1980-1985 there is a positive and significant correlation between the growth in the accessibility indices. In the other periods the correlations are not significant and both positive and negative signs. Thus, at the level of Corop-regions, the indications are not strong that infrastructure supply leads to a systematic bias for certain regions. However, at the more aggregate level of the three zones mentioned in Table 3.4 (Randstad, intermediary and peripheral zone), it is clear that accessibility increases have been consistently strongest in the peripheral regions.

# 4 THE INFLUENCE OF THE CONSTRUCTION OF THE A1 HIGHWAY; A REFERENCE REGION APPROACH

## 4.1 Introduction to the A1 highway and the A1-regions

The **A1** is the highway which runs from Amsterdam, via Amersfoort-Apeldoorn-Almelo to the German border. In Germany this highway (E8) goes on to Berlin and Poland. In the central parts of the Netherlands it was mainly completed in 1972 en 1973; in the eastern part (Twente) several parts were opened between 1978 and 1992. The road runs through several Corop-regions: Larger-Amsterdam, Utrecht, the Veluwe, Southwest-Overijssel and Twente (see Appendix 2).

In order to study the impact of the construction of the A1 on the regional economy the reference region approach will be used in this section.

In the reference region approach we try to determine the impact of the construction of the A1 on the regional economy by comparing the employment growth in the A1-regions with that of reference regions. These reference regions are comparable with the A1-regions in terms of economic structure and location, but in these regions little or no construction of infrastructure took place in the period(s) considered.

*Table 4.1 Employment growth in the Netherlands and the A1-regions (1970 = 100)*

| | 1970 | 1975 | 1980 | 1985 | 1990 |
|---|---|---|---|---|---|
| Netherlands | 100 | 101 | 105 | 100 | 115 |
| Veluwe | 100 | 111 | 118 | 117 | 136 |
| Sw-Overijssel | 100 | 100 | 106 | 98 | 120 |
| Twente | 100 | 97 | 99 | 90 | 104 |

Source: Own calculations from: CBS, REJ.

The study is carried out for three A1-regions, which are situated in the intermediary zone: the Veluwe, Southwest-Overijssel and Twente. In the analyzed period the A1-regions all had a different economic development. In Table 4.1 the index is given of the growth of employment.

The **Veluwe** isone of the biggest natural areas in the Netherlands, and is a popular location region for people as well a companies. The regional economy is characterized by a large employment share in the government sector, mainly because of defence employment. Between 1970-1990 the service sectors grew faster than the service sectors at a national level. The growth in employment was relatively high between 1970-1990: 36% (Netherlands 15%). The shift component was also positive in most periods (see also Table 4.2). The A1 in this region was constructed in 1972 and this highway is one of the main transport corridors in this region.

**Southwest-Overijssel** is a small, mainly rural region. Traditionally the share of the industry sector in total employment is relatively high, although the service sector was growing faster than at a national level, especially in the 1980s. The growth rate of the employment stayed behind the national average until 1985, the shift was positive, however, between 1970-1980. After 1985 the employment growth as well as the relative shift was relatively high. The A1 was constructed in 1972 en 1973 and this is the only highway in this region.

Finally, **Twente** was traditionally characterized by a strong textile-industry sector, which declined to a large extent in the analyzed period: in 1970 15.8% of total employment was found in this sector, in 1990 it was only 4.1%. The spatial structure of Twente is characterized by the existence of some larger cities. Until 1985 this region experienced a negative employment growth, after 1985 the employment grew rapidly, however. When the growth is corrected for the sectoral structure, the region had a positive shift in three of the four five-year periods. The A1 was mainly opened between 1978 and 1992, this highway is the only one in this region.

The growth of employment of these regions, corrected for the sectoral composition by a shift-share analysis, was compared with the growth rate of the remainder of the intermediary zone in the Netherlands and some specific reference regions.

### 4.2 The A1-regions compared with the remainder of the intermediary zone

In Table 4.2 a comparison is made between the relative shift in the three A1-regions and the remainder of the intermediary zone.

When we compare the relative shifts in the periods of opening of the A1 we see that in the Veluwe the shift is much higher than in the intermediary zone. At first sight this seems to be the result of the A1-construction. When the sectoral structure is investigated however, it appears that the high relative shift is mainly caused by growth of the government sector, in the form of a growth of defence-employment. It is not likely that this employment is attracted by the construction of the A1.

*Table 4.2 Relative shifts in the intermediary zone and A1-regions*

| | '70-'75 | '75-'80 | '80-'85 | '85-'90 |
|---|---|---|---|---|
| Intermediary zone | 0.05 | 0.01 | 0.02 | 0.04 |
| Veluwe | **0.10*** | -0.00 | 0.03 | 0.05 |
| Sw-Overijssel | **0.01** | 0.02 | -0.02 | 0.08 |
| Twente | **0.03** | **0.02** | **-0.02** | **0.02** |

* Bold printed are the periods in which the A1 was opened
Source: Own calculations from CBS, REJ.

In the other periods during which construction took place the relative shift in Twente is somewhat higher in the period 1975-1980. In the other relevant periods the shift is lower than in the intermediary zone, however. Also an investigation of lagged effects does not lead to clear results on an impact of highway construction on regional employment growth. So it is concluded that a positive influence of the construction of the A1 on the shift cannot be proven by using the remainder of the intermediary zone as reference region.

Although it is certainly relevant to compare the development of the A1-regions with that in the intermediary zone, it is clear the intermediary zone is not an entirely satisfactory reference region. The reason is that in the periods concerned in the intermediary zone also other highway construction projects took place. Therefore we carried out a more detailed analysis with reference regions which did not experience extensive highway construction projects during the periods concerned.

### 4.3 The Veluwe compared with the Achterhoek

The Achterhoek is like the Veluwe a rural region, which is considered to be an attractive living and location region. Little main road infrastructure has been constructed in this region between 1970 and 1990, which makes it a good reference region for our purpose. The relative shifts of the regions are presented in Table 4.3.

*Table 4.3 Relative shift in the Veluwe and the Achterhoek*

| | '70-'75 | '75-'80 | '80-'85 | '85-'90 |
|---|---|---|---|---|
| Veluwe | **0.10*** | -0.00 | 0.02 | 0.05 |
| Achterhoek | 0.05 | 0.05 | -0.04 | 0.07 |

* Bold printed are the periods in which the A1 was opened
Source: Own calculations from CBS, REJ.

When we compare the relative shift of both regions in the period of opening of the A1 (1970-1975) we see a higher shift in the Veluwe; as already mentioned above however, this is mainly caused by a growth of the government employ-

ment. In the Achterhoek the relative shift was also high during this period, but here it was caused by market sectors, so a clear influence of the construction of the A1 on the employment in the Veluwe is not proven during the 1970-1975 period. The same holds true for a lagged effect.

### 4.4 Southwest-Overijssel compared with Middle-Limburg and Northeast-North-Brabant

Middle-Limburg and Northeast-North-Brabant have been chosen as reference regions for Southwest-Overijssel. Both regions are like Southwest-Overijssel situated in the intermediary zone and have an economic structure with an emphasis on industry.

When we compare the relative shifts in the regions, it appears that the relative shift in both reference regions is much higher in the period of opening of the A1 (see Table 4.4), so it follows clearly that no effect can be proven of the opening of the A1. The same accounts for a lagged influence.

*Table 4.4 Relative shift in the regions Southwest-Overijssel, Northeast-North-Brabant and Middle-Limburg*

| | '70-'75 | '75-'80 | '80-'85 | '85-'90 |
|---|---|---|---|---|
| Sw-Overijssel | **0.01*** | 0.02 | -0.02 | 0.08 |
| Ne-North-Brabant | 0.10 | 0.03 | 0.05 | 0.10 |
| Middle-Limburg | 0.11 | 0.09 | 0.02 | 0.06 |

* Bold printed are the periods in which the A1 was opened
Source: Own calculations from CBS, REJ.

### 4.5 Twente compared with the agglomeration Arnhem/Nijmegen and Southeast-North-Brabant

Both Arnhem/Nijmegen and Southeast-North-Brabant are like Twente characterized by medium sized cities, with around them a rural area. The regions are chosen as reference regions, because Arnhem/Nijmegen was like Twente characterized by a restructuring of the industry, while also Southeast-North-Brabant has a large emphasis on the manufacturing sector. Both regions are well supplied with main road infrastructure, in Twente relatively more infrastructure was constructed.

When the relative shifts of the regions are compared, we see that the relative shifts in Twente are in every period higher than in Arnhem/Nijmegen, while it is in most periods lower than in Southeast-North-Brabant.

From Table 4.5 it follows that there might be an influence when we compare Twente with Arnhem/Nijmegen. No influence of the construction of the A1 can be proven when Twente is compared with Southeast-North-Brabant. So no clear conclusion can be drawn, therefore.

*Table 4.5 Relative shift in the regions Twente, agglom. Arnhem/Nijmegen en Se-North-Brabant*

| | '70-'75 | '75-'80 | '80-'85 | '85-'90 |
|---|---|---|---|---|
| Twente | **0.03*** | **0.02** | **-0.02** | **0.02** |
| Agglom. Arnhem/Nijm. | -0.00 | -0.02 | -0.03 | 0.01 |
| Se-North-Brabant | 0.03 | -0.00 | 0.02 | 0.06 |

* Bold printed are the periods in which the A1 was opened
Source: Own calculations from CBS, REJ.

### 4.6 Remarks on the reference region approach

It is clear that the results of the reference region approach are dependent on the choice of the reference region; but also when we use other ones the conclusion appears to remain the same. Another problem is that this approach is rather crude, because no other specific features of the regions are taken into account. Clearly, in a relative small country with only 40 statistical regions, one cannot select reference regions in such a way that they satisfy all requirements for a quasi experimental method (cf. Isserman et al., 1989). To meet with this objection we will estimate a model in the next paragraph, where several region-specific factors are taken into account. Finally it should be mentioned that since the spatial scale level of Corop-regions is rather high, it is very well possible that an influence can be proven on a lower spatial level. This would mean that highways induce a relocation of employment **within** regions towards points of access leading to corridor effects, but that regional totals as such are not influenced.

## 5 A REGIONAL LABOUR MARKET APPROACH

### 5.1 The regional labour market: an introduction

Given the limitations of the reference region approach, it is useful to estimate a model in which the various regional features are included in an explicit way. Let us take as a starting point the next production function:

$$Q_r = f(L_r, K_r, B_r, A_r)$$

where:
$Q_r$ volume of production in region r
$K_r$ capital in region r
$L_r$ labour in region r
$B_r$ accessibility of region r
$A_r$ other factors in region r, for example other types of infrastructure and urbanization (dis-)economies.

Transport infrastructure is represented by means of the factor B, thus it enters the production function via the services it provides as measured by means of accessibility (see: Forslund and Johansson, 1993). This formulation of the role of transport infrastructure in the production function allows one to take into account the spatial spill over effects associated with the supply of infrastructure.

If we may assume that resources are allocated in such a way that regional profits are maximized given the price of the output at the world market, we arrive at a labour demand function with the following arguments:

$$L_r = h(s_r, w_r, p, B_r, A_r)$$

where:

$s_r$ price of capital in region r
$w_r$ price of labour in region r
p given price of the output

In our application we operationalize these arguments as follows.

*Price of capital ($s_r$)*

The price of capital is equal for all regions with one exception: firms may receive subsidies on investments. Therefore, we take a regional policy variable to take into account these subsidies. The variable assumes the value 1 in regions receiving subsidies and the value 0 in the other regions. The sign of impact of investment subsidies on employment is uncertain. If substitution effects dominate, it will be negative, but if output effects dominate, it will be positive.

*Price of labour ($w_r$)*

Because of the strong national component in the annual wage negotiations and the uniform national minimum wage policy, interregional wage differentials are very small in the Netherlands. This is one of the causes of frictions on regional labour markets. Therefore we use the percentage of the labour force with an unemployment duration less than one year as a proxy for the difficulty to recruit labour. Long term unemployed are not taken into account in this measure because their probability of recruitment is often low.

A second labour market variable taken into account is the level of education of the regional labour force.

*Price of output (p)*

The impact of the price cannot be estimated with this model, because p is assumed to be the same for all regions.

*Accessibility ($B_r$)*

This concept has already been defined in section 3.3. We will use two accessibility indicators: one for domestic destinations and one for international destinations in neighbour countries to test whether the process of European economic integration has an impact on regional development. In the given

formulation we may expect a positive impact of accessibility on employment. However, if we take into account the theoretical considerations given in section 2, we note that substitution effects may lead to a negative impact on employment. In addition, from a interregional trade perspective, an increase in accessibility may make regions more vulnerable to competition by producers from elsewhere. In order to test the latter consideration, one may investigate whether importing sectors in a region are influenced in a different way by a change in accessibility compared with exporting sectors. Whether a sector is importing or exporting can be operationalized by means of the locational quotient.

*Other regional factors ($A_r$)*

The degree of urbanization is used as an explanatory variable to account for urbanization (dis-)economies.

For a detailed definition of the variables we refer to Bruinsma et.al. (1994). We estimated the model for total regional employment as well as for the separate sectors.

### 5.2 The results of the model for total regional employment

In the final estimation (see Table 5.1) the relative shift in employment of a region during a five year period is explained by:

| | |
|---|---|
| acc | the relative change in domestic accessibility |
| int | the relative change in international accessibility |
| unemp | the relative change in short term unemployment |
| educ | the relative change in the level of education |
| urb | the level of urbanization |
| pol | the regional policy variable (a dummy) |

*Table 5.1 Estimation results of the model for total regional employment (relative shift)*

| | '70-'75 | | '75-'80 | | '80-'85 | | '85-'90 | |
|---|---|---|---|---|---|---|---|---|
| | Coeff | T | Coeff | T | Coeff | T | Coeff | T |
| acc | -0.94 | -2.07 | 0.74 | 0.81 | 0.22 | 0.54 | 2.12 | 2.11 |
| int | 0.08 | 0.51 | 0.20 | 0.28 | 1.47 | 1.26 | -0.67 | -1.08 |
| unemp | -0.01 | -1.10 | 0.22 | 4.86 | 0.05 | 2.21 | 0.15 | 1.18 |
| educ | -0.54 | -3.36 | -0.09 | -0.66 | 0.03 | 0.30 | -0.07 | -0.73 |
| urb | -0.65 | -5.04 | -0.15 | -1.15 | -0.19 | -2.96 | -0.28 | -2.14 |
| pol | -0.10 | -1.92 | -0.04 | -0.91 | -0.06 | -2.55 | -0.07 | -1.75 |
| Cst | 0.51 | 5.36 | -0.02 | -0.23 | 0.02 | 0.33 | 0.00 | 0.05 |
| $R^2$ | 0.52 | | 0.59 | | 0.50 | | 0.26 | |

Since there are forty observations, a 95% significance level is found at a T-value of 1.69.

It appears that the change in domestic accessibility had a significant negative impact on the employment in the period 1970-1975, while in the period 1985-1990 this impact was positive. In the other periods no significant impact is proven. The international accessibility does not have a significant impact on regional employment. So a clear impact of a change in accessibility on the shift in regional employment cannot be proven.

Of the other variables the change in unemployment rate has the expected significant sign in two five-year periods. The level of education does not have the expected impact. The level of urbanization does have a significant negative sign in three periods, so the urban-rural manufacturing shift (see section 3) seems to have more influence than agglomeration effects. The regional policy has a negative significant sign in three periods, which may mean, that the substitution effect is larger than the output effect. Another possible interpretation is that the regions receiving government support are regions with structural weaknesses, not incorporated by the other variables. Government policies are not strong enough to overcome these structural weakness and as a consequence a negative sign is found for the policy variable.

### 5.3 Results for separate sectors: the transport and communication sector

A sector where a significant impact of a change in accessibility on employment growth may be expected is the transport and communication sector. We estimated the model with the above mentioned variables. The results are given in Table 5.2.

*Table 5.2 Results of the model for the transport and communication sector (relative employment growth)*

| | '70-'75 | | '75-'80 | | '80-'85 | | '85-'90 | |
|---|---|---|---|---|---|---|---|---|
| | Coeff | T | Coeff | T | Coeff | T | Coeff | T |
| acc | -0.44 | -0.54 | 2.45 | 0.89 | 3.45 | 2.12 | 5.54 | 2.37 |
| int | 0.54 | 1.95 | -1.76 | -0.80 | 10.29 | 2.26 | -1.81 | -1.25 |
| educ | 0.08 | 0.29 | -0.22 | -0.54 | 0.26 | 0.78 | -0.18 | -0.74 |
| unemp | -0.00 | -0.36 | 0.31 | 2.23 | 0.19 | 1.99 | 0.74 | 2.51 |
| pol | -0.11 | -1.27 | 0.06 | 0.41 | 0.21 | -2.13 | -0.24 | -2.48 |
| urb | -0.04 | -0.17 | -0.21 | -0.54 | -0.34 | -1.39 | -0.90 | -2.97 |
| Cst | 0.04 | 0.27 | 0.16 | 0.74 | -0.04 | -0.15 | 0.37 | 1.72 |
| $R^2$ | 0.11 | | 0.26 | | 0.55 | | 0.39 | |

The domestic accessibility has in the three periods between 1975 and 1990 a significant positive influence on the employment in this sector. The same accounts for the international accessibility in the periods 1970-1975 and 1985-1990. So it may concluded that the change in accessibility has a positive impact on the employment in this sector.

The other variables give about the same results as the model for the total employment: the change in unemployment rate has a positive influence on the employment growth in this sector; the regional policy has twice a significant negative sign and the level of urbanization has once a negative significant sign. The education level does not have a significant influence on the employment of this sector.

The estimates for the other sectors are given in Bruinsma et.al. (1994). In general it can be said that with individual sectors the explained part of total variance ($R^2$) is lower than for total regional employment. The domestic as well as the international accessibility do only have incidentally a significant influence on the other sectors. In an alternative specification we tested whether the accessibility variable has a different impact for importing and exporting sectors, but this did not yield better results for the individual sector estimates. The conclusion is that the transport and communication sector is the only one where an influence can be proven on the Corop-level.

## 6. CONCLUSIONS

In terms of employment growth, the intermediate zone has been most successful during the period considered. However, the increase in accessibility has been largest in the peripheral zone and this already indicates that there is no simple mono-causal relationship between the development of accessibility and employment.

In the reference region approach we compared A1-corridor regions with reference regions, which had about the same locational features and sectoral structure, but had less construction of highways in the construction period of the A1. By comparison of the relevant shift in employment no clear impact of highway construction on regional employment could be proven, only incidentally the shift in the A1-regions was higher than in the control region.

Finally a regional labour market model was estimated with also other regional features next to the domestic and international accessibility as variables. For total employment no unambiguous impact could be proven; the impact of the domestic accessibility was significantly negative in one period and significantly positive in another period. Only for the transport and communication sector a clear positive impact was found.

From this empirical research it can be concluded that there is no evidence that the construction of main road infrastructure and the resulting change in accessibility has a clear impact on overall employment in regions. This conclusion holds true for the spatial level of Corop-regions. It is very well possible,

however, that a positive impact on the regional employment may be found in a corridor analysis at a lower spatial level. This will be the subject of a next paper on this subject (Jorritsma et al., 1994).

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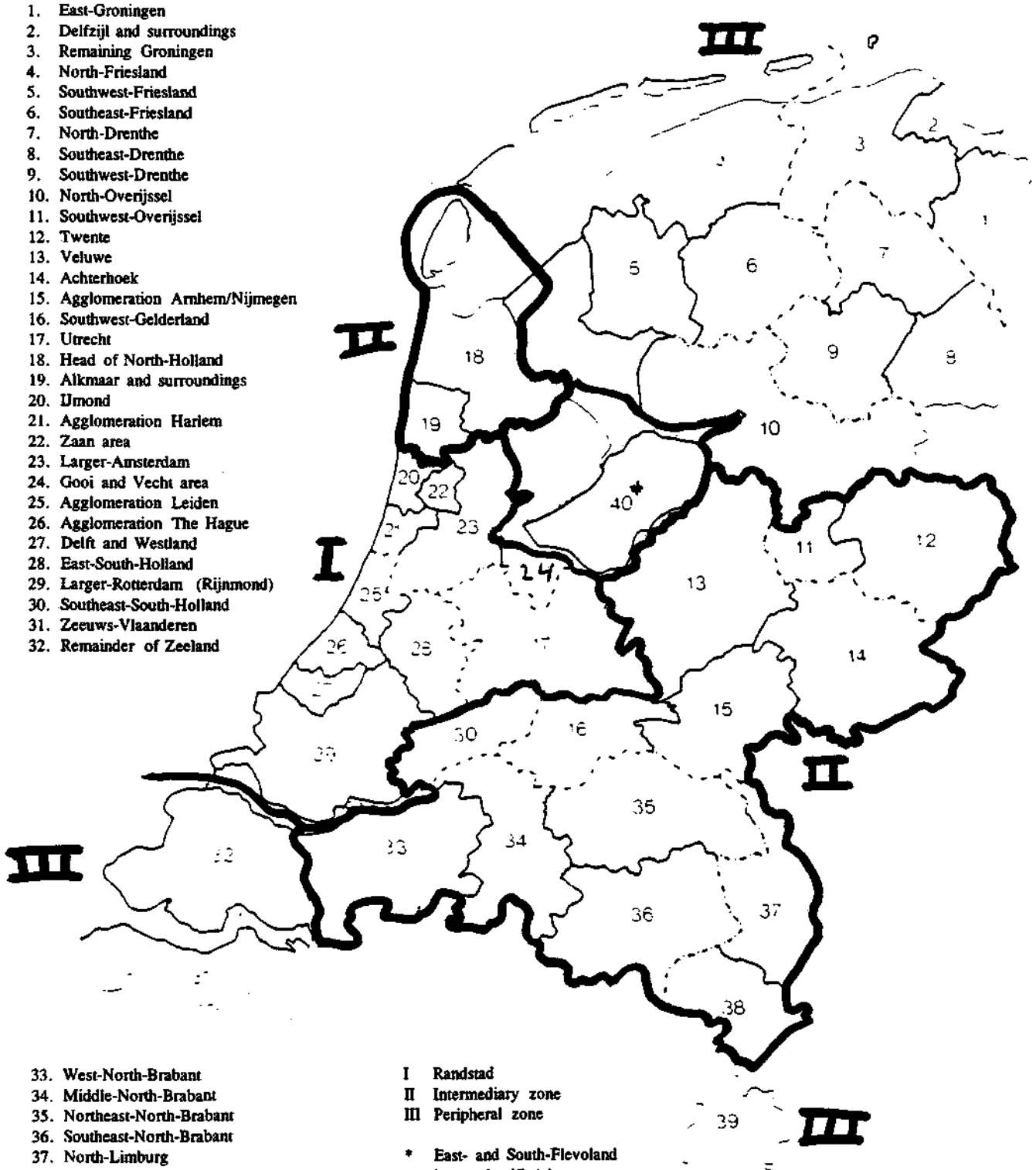
## APPENDIX 1 THE NETHERLANDS SUBDIVIDED IN 40 COROP-REGIONS AND 3 ZONES

1. East-Groningen
2. Delfzijl and surroundings
3. Remaining Groningen
4. North-Friesland
5. Southwest-Friesland
6. Southeast-Friesland
7. North-Drenthe
8. Southeast-Drenthe
9. Southwest-Drenthe
10. North-Overijssel
11. Southwest-Overijssel
12. Twente
13. Veluwe
14. Achterhoek
15. Agglomeration Arnhem/Nijmegen
16. Southwest-Gelderland
17. Utrecht
18. Head of North-Holland
19. Alkmaar and surroundings
20. IJmond
21. Agglomeration Haarlem
22. Zaan area
23. Larger-Amsterdam
24. Gooi and Vecht area
25. Agglomeration Leiden
26. Agglomeration The Hague
27. Delft and Westland
28. East-South-Holland
29. Larger-Rotterdam (Rijnmond)
30. Southeast-South-Holland
31. Zeeuws-Vlaanderen
32. Remainder of Zeeland




33. West-North-Brabant
34. Middle-North-Brabant
35. Northeast-North-Brabant
36. Southeast-North-Brabant
37. North-Limburg
38. Middle-Limburg
39. South-Limburg
40. East- and South-Flevoland (polder)

I Randstad
II Intermediary zone
III Peripheral zone

* East- and South-Flevoland is not classified in a zone because this region was still almost 'empty' in 1970, so the growth rates were very high.

**APPENDIX 2** **THE DATES OF THE OPENING OF THE HIGHWAY A1 AND THE A1-REGIONS**

*Cities*:
A Amsterdam
B Amersfoort
C Apeldoorn
D Almelo

*Regions:*
23 Larger Amsterdam
24 Gooi en Vecht area
17 Utrecht
13 Veluwe
11 Southwest-Overijssel
12 Twente

* Opening dates vary from 1958-1973.